Air Force Research Laboratory|AFRL

Science and Technology for Tomorrow's Air and Space Force

Success Story

IMPROVED LUBRICANTS AND ADDITIVES INCREASE OPERATIONAL LIFE OF SPACE MECHANISMS

Extending the operating life of military and commercial satellites would enhance the payback of each satellite launched, while reducing the costs associated with constructing and launching replacements. The knowledge that engineers at the Materials and Manufacturing Directorate gain through their research on improved base fluids and ultra low volatility boundary lubrication/lubricity additives will be a determining factor in selecting longer lasting lubricants and additives for future space systems.

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Accomplishment

Improved base fluids and ultra low volatility boundary lubrication/lubricity additive research could help extend the operational life of military and commercial satellites and enhance the reliability of their components. Directorate research efforts will lead the way to substantial reductions in cost by increasing the length of time future satellites can remain in orbit, and have significant implications for aviation and commercial industry application of liquid and grease lubricants.

Background

As the use of satellites for military and commercial communication, navigation and global surveillance applications continues to increase, the high costs for building and launching them are driving the need to extend their useful life from the current 5-8 years to 15 years and beyond. One of the most cost-effective ways to extend the lives of satellites is to improve the lubrication of their mechanical systems, resulting in more reliable and longer operating components.

Two factors are vitally important in retaining good lubrication in liquid/grease-lubricated systems over an extended period in vacuum environments. First, the lubricant base oil must remain in place—not volatilize or creep into other areas—and it must not change in other ways—become thicker or change chemically. Second, the additive(s) which provide or enhance many of the required characteristics must not evaporate, degrade, or be consumed.

Researchers at the directorate's Nonmetallic Materials Division evaluated three major classes of synthetic hydrocarbons for space applications including liquid/grease formulations with polyalphaolefins (PAOs), multiple alkylated cyclopentanes (MACs), and silahydrocarbons (SiHCs). The research effectively demonstrated that all three classes offer major advantages over conventional mineral oil lubricants for space applications. Four-ball and reciprocating tribometer methods, in a nitrogen environment, were key in demonstrating significant, improved lubrication performance from the candidate lubricants.

The fluids evaluated during the study—PAOs, MACs, and SiHC oils—are the best possible fluids in the hydrocarbon family for space applications (viscosity index, volatility, traction, change with evaporation, and availability must be considered for specific applications). The research team also found that additives show different levels of anti-wear effectiveness among the three base fluids and in the greases. In oils, for example, only long-term soluble additives are acceptable, but additive solubility is not critical for greases.

Materials and Manufacturing
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (02-ML-26)